
Space Weather Technical Forecast

Issued on Monday, 28 November 2022 at 12:49 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Chance of Minor Geomagnetic Storm (G1) intervals through the period. Chance of Active electron fluence each day.
Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Very Low in the past 24 hours, with no discernible flares. There are currently four sunspots on the Earth-facing disk, which are currently rather small, simple and apparently stable. Three regions are located in the western hemisphere, two of which are simple unipolar alpha regions. AR3151 in the southwest continues to grow in extent with a mature penumbra developing on its lead spot and the emergence of new trailing spots, with it being reclassified Dsi/Beta. AR3152 in the northeast continues to show a reduction in size and complexity. No new Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE and DSCOVR at L1, were indicative of positive coronal hole HSS influences and perhaps the arrival of an embedded CME from a filament eruption on 24 Nov. Solar wind speeds rose erratically from 420 km/s at the start of the period to around 580-600 km/s by the end of the period. Density was predominantly average or just above average. The interplanetary magnetic field, IMF Bt, rose from weak to moderate, peaking at 12nT at 28/0428 UTC. The north south component has fluctuated for much of the period between +9/-10, falling neutral for a time. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was largely Unsettled (Kp 3) with one Active (Kp 4) period late on 27 Nov and two Minor Storm (G1/Kp 5) intervals early day 1 (28 Nov).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was initially at High levels, falling to Moderate levels around 27/1900 UTC and has been largely at background levels since 28/0000 UTC. Electron fluence levels have been on a rising trend but plateaued around 28/0000 UTC and has remained below the Active (1e8 integrated pfu) threshold. Observed fluence at 28/0000 UTC was 4.28e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low or Very Low, with a chance of isolated C-class flares and a slight chance of isolated M-Class flares. Three of the four numbered regions on the visible disc are transiting toward the western limb, with the other region located close to the central meridian. The emergence of regions across the eastern limb over the forecast period sees the slight chance of Moderate solar activity and isolated M-class flares persist.

Solar Wind / Geomagnetic Activity: Earth is currently under the waning influence of a HSS from CH48/+, further enhancement is likely occurring as a result of the arrival of a CME from 24 Nov, persisting into day 2 (29 Nov). CH49/+ in the northern hemisphere is, expected at Earth from day 2 (29 Nov), with speeds more typically around 500-550 km/s. CH51/+, with its leading edge currently near the central meridian with speeds likely around 550-600 km/s, the HSS of this

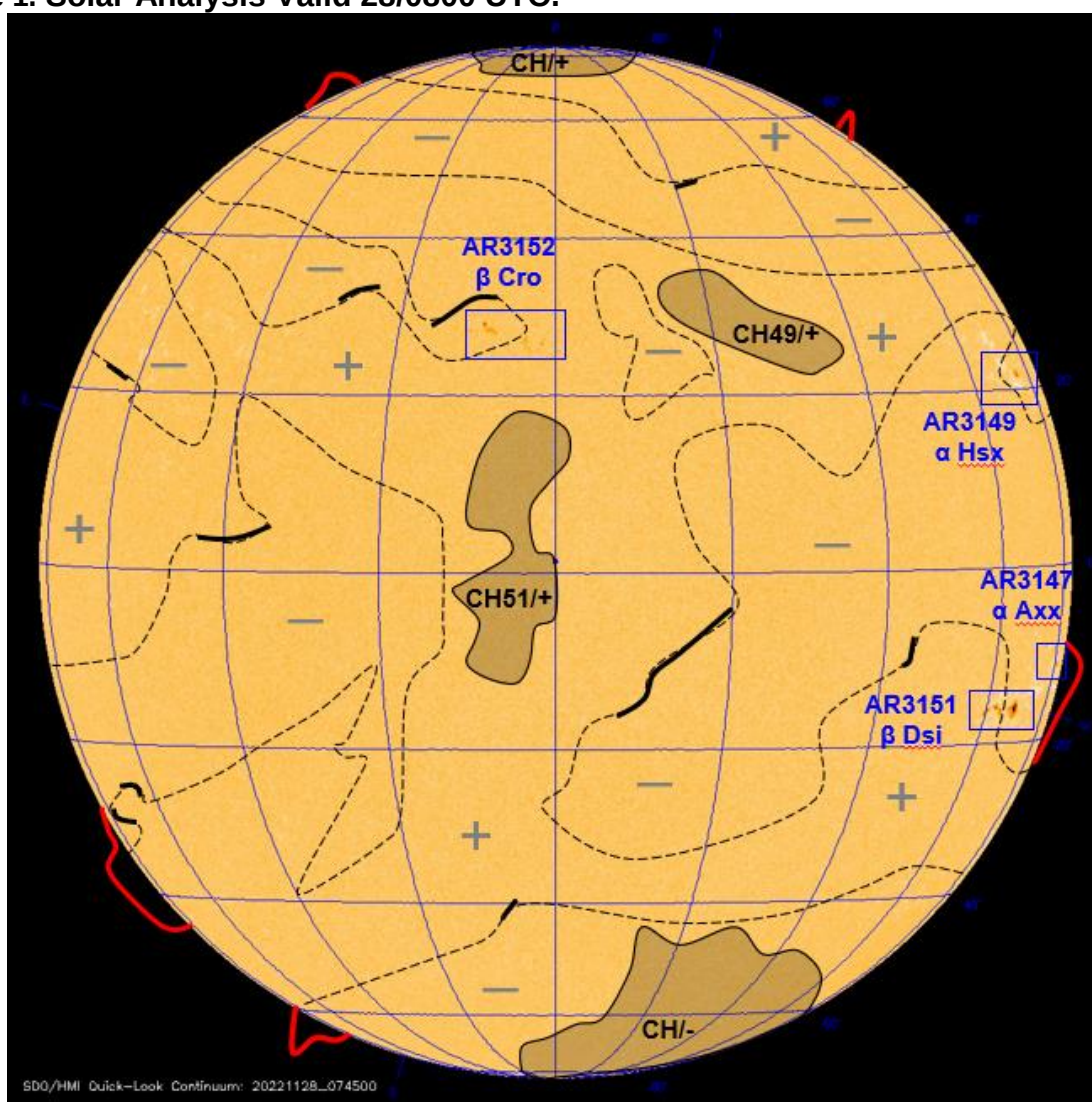
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feature is expected to arrive at Earth either late on day 3 or more likely into day 4 (30th-1st). Further enhancements due to CMEs are not currently anticipated beyond day 2.

Geomagnetic activity is expected to be mainly Quiet to Unsettled, with Active intervals and a chance of G1/Minor storm intervals each day due to either CME or coronal hole HSS effects. This risk increases on day 4 due to the arrival of CH51/+.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at Background levels throughout. High energy electron flux (greater than 2 MeV) observed by GOES16 levels are expected to remain at largely Background to Moderate levels, but may continue to reach High levels during the diurnal maxima. Longer periods of High flux levels are not expected. Fluence levels will continue to respond by increasing with a chance of reaching the 1e8 integrated electron fluence active threshold each day. Confidence wanes later in the period due to the complex impacts owing to a combination of CME and coronal hole HSS arrivals.

Figure 1. Solar Analysis Valid 28/0800 UTC.



Key: Filament — , Prominence — , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - γ - δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

Several recent CMEs have occurred on, or close to the Earth-Sun line. On 24 Nov a two-stage filament eruption was observed from a region near the centre disc in the southern hemisphere, these resulted in a faint CME signature on coronagraph imagery, however, analysis of this feature was very difficult, with significant imagery gaps compounding what was a faint CME trace. An Earth-directed component was expected, with effects of this presenting currently at L1, effects may persist into early day 2 (29 Nov). Further enhancements due to CMEs are not currently anticipated beyond day 2.

Earth is assessed to currently be in the waning influence of a HSS from CH48/+ which has now passed beyond the western limb. CH49/+ in the northern hemisphere is a recurrent feature, which is expected at Earth later day 1 (28 Nov) into day 2 (29 Nov), with speeds more typically around 500-550 km/s. The larger CH51/+, with its leading edge currently close to the central meridian is also a recurring feature. With speeds of 550-600 km/s, the HSS of this feature is expected to arrive at earth either late on day 3 or into day 4 (30 Nov-1 Dec).

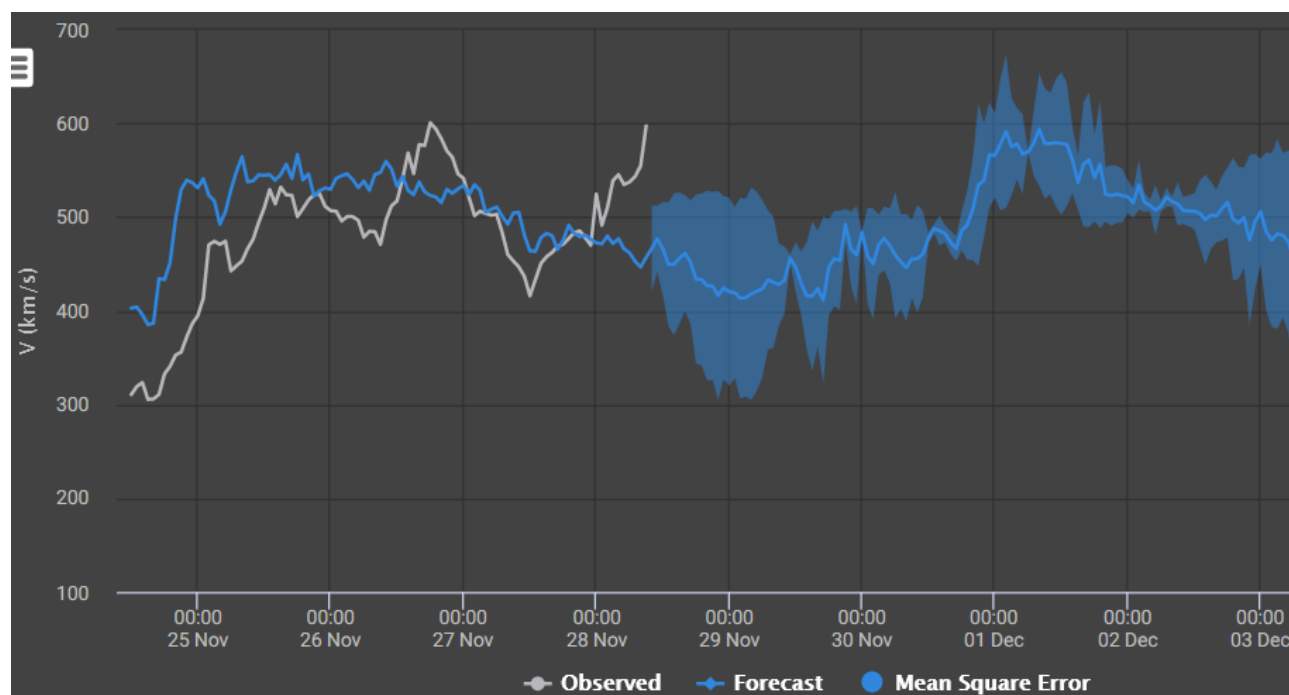
Geomagnetic activity is expected to be mainly Quiet to Unsettled, with Active intervals and a chance of G1/Minor storm intervals each day due, predominantly, to coronal hole HSS effects. This risk increases into day 4 due to the projected connection to CH51/+.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	40	30	30	40
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/1904	Partial	Filament Eruption	S Hemisphere. Centre disc.	630 km/s	28/0000-29/0000 UTC	Limited effects expected. Low confidence

Figure 2: MOSWOC SWPM showing projected solar wind enhancements through the period



Radio Blackouts - X-Ray Flares:

Solar activity is forecast to remain Low or Very Low over the forecast period, with the current four numbered Earth-facing sunspots currently rather small, simple and apparently stable. Three of the regions are transiting toward the western limb, with the other region located close to the central meridian.

The Carrington locations for several small far-sided regions suggest arrival at the eastern limb over days 1 and 2 (28-29 Nov), and a larger region to arrive from day 3 (30 Nov). Coronagraph imagery would infer that the upcoming sunspot groups have shown some evidence of flare and CME activity. Probabilities are being maintained until emergence of these spots provides more evidence.

Overall there is a chance of further isolated C-class flares, and a slight chance of isolated M-flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	5	5	5	5
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background levels and is expected to remain at this level throughout.

Radiation Storms	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq \text{S1}$	No	1	1	1	1
Very Active	$\geq \text{S3}^*$	No	1	1	1	1

* S3 $\geq 10 \text{ MeV} \geq 1000 \text{ pfu}$ and / or $\geq 50 \text{ MeV} \geq 10 \text{ pfu}$. (pfu = $\text{cm}^{-2} \text{sr}^{-1} \text{s}^{-1}$)

High Energy Electrons Event ($\geq 2\text{MeV}$):

High energy electron flux (greater than 2 MeV) observed by GOES16 was initially at High levels but fell to Moderate levels around 27/1900 UTC and has been largely at background levels since 28/0000 UTC. In coming days, flux levels are expected to remain largely Background to Moderate, but may continue to reach High levels during the diurnal maxima. However, impacts of a CME arrival (on days 1 and 2) and coronal hole HSS influences through the period may have the impact of knocking out electrons or compressing the electron field, acting to inhibit the potential for a protracted period of High flux levels.

Fluence levels are expected to continue to respond by increasing, with a chance of exceeding the $1\text{e}8$ integrated electron fluence active threshold each day. The REFM is currently considered to be giving good guidance, however confidence wanes later in the period due to the potential response and recovery deriving from CME and coronal hole HSS arrivals and their effects during the period.

GEO Electron Environment	Level ($\text{cm}^{-2} \text{sr}^{-1} \text{day}^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^8$	No	40	40	30	30
Very Active	$\geq 2 \text{ MeV}$ $\geq 1 \times 10^9$	No	1	1	1	1

Figure 3: REFM showing projected fluence, with persistence suggesting periods of active fluence

